Hubble Facts

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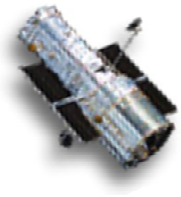

Hubble Space Telescope

SERVICING MISSION PROCESS

Preparation for a Hubble Space Telescope (HST) servicing mission begins about 5 years before launch with selection of new instruments in addition to any Hubble subsystem upgrades or repairs that are required to maintain the observatory. Mission planning and design also starts at this time. An initial mission timeline is developed and the specific hardware to be carried to and from orbit on the Space Shuttle is identified. There are five main parallel activities that become an integrated effort once mission-level integration and testing begins at launch-18 months. These activities are the development of: Instruments, HST "Black Boxes," Shuttle Carriers, EVA Procedures and Mission Execution Plans.

Shuttle Documentation and Analytical Integration

Analytical integration is governed by the Payload Integration Plan (PIP), which defines the responsibilities between the HST and Shuttle Programs for planning and implementing the Servicing Missions.

The PIP Annexes are a series of documents that contain the "hows" of physical and analytical integration. Detailed structural, thermal and electromagnetic compatibility analyses are conducted to insure the HST payload is compatible with the Orbiter and the planned on-orbit timeline. Results of these analyses are captured in the PIP Annexes. The actual mission execution procedures, or "Flight Data Files" in Shuttle vernacular, are produced from the requirements and data that are contained in the PIP Annexes.

Crew Selection and Training

Prior to the actual flight crew selection, a series of underwater hardware and EVA procedures development runs are conducted at the NASA Neutral Buoyancy Laboratory (NBL) by the HST program. These runs are conducted in order to hand over a mature set of hardware designs and EVA procedures to the actual flight crew. Around 18 months before launch, NASA selects the members of the astronaut crew who will perform space walks and operate the Shuttle's robotic arm. They begin classroom training, where they integrate HST-specific data with their space walk training. The EVA crewmembers perform most of their EVA training underwater, in full spacesuits, working on high fidelity replications of the actual flight hardware. Typically the EVA crew spends 12 hours in the water training for each planned hour of on-orbit servicing. They also travel to other locations for actual hands-on experience with flight hardware

and/or high fidelity mockups. The crew commander and pilot are named around 11 months before launch.

Mission Execution Planning

The actual execution of a HST Servicing Mission is a highly choreographed integration of Shuttle operations, HST ground commanding and Shuttle and HST support functions. The choreography is achieved by producing an integrated mission script called the Servicing Mission Integrated Timeline (SMIT). HST ground command scripting is contained in the Command Plan. The Servicing Mission Operations Working Group, which is an integrated team of representatives from the HST and the Shuttle programs, produces the SMIT and the Command Plan.

In addition to the Flight Data Files, which aid in the development of the SMIT, the HST Program develops an extensive number of Contingency Operations Procedures, Fault Isolation Procedures, Alternative Command Plans and Contingency Procedures for console use during the mission.

Simulations

Approximately 12 months before launch, the HST Program begins internal simulations with some support from Shuttle program personnel. The purpose of the simulations is to train the Flight Control Team to fly the mission. Approximately 22 internal simulations are conducted for each flight.

The timeline for each mission segment (rendezvous and capture, individual EVA days, and deployment of the HST from the Shuttle) is executed so that the Flight Control Team becomes familiar with the planned activities. Anomalies are introduced to test the flight control team reactions and knowledge of the contingency procedures.

After the Flight Operations Review, Joint Integrated Simulations are performed with the entire Space Shuttle Flight Control Team. The same mission segments executed in the internal simulations are used for the joint integrated simulations.

Safety

The Space Shuttle Program has implemented a rigorous payload safety process to ensure safe payload related operations both during ground handling and in space. The primary objectives of the payload safety review process for an HST servicing mission are to identify the potential hazards to the payload and to assure that the HST Program's hazard controls and verifications of those controls are adequate and in compliance with safety requirements.

Kennedy Space Center Operations

About 3 months before launch, the HST SM payload hardware arrives at the launch site at Kennedy Space Center. The Shuttle carriers are unpacked and configured for launch, and post-ship functional tests are performed. Prior to installation into the Shuttle, a verification test is performed with an electrical simulator of Shuttle and the installation of the HST contamination sensitive hardware into the SSE. The HST hardware is installed into the Shuttle at the Launch Pad approximately 20 days before launch. Prior to Shuttle payload bay door closure, payload-to-Shuttle interface verification and end-to-end system tests are performed. The actual launch is timed to allow for a fuel-efficient rendezvous with HST.

SERVICING MISSION FLOW